

THAT WHICH IS CLAIMED IS:

1. A method of rapidly and accurately determining the fat and oil content of a sample that also contains moisture in amounts that would otherwise preclude NMR determination of  
5 the fat and oil content, the method comprising:
  - weighing the sample;
  - drying the sample by subjecting the sample to electromagnetic radiation in the microwave frequencies;
  - transferring the entire sample to an NMR analyzer;

10 measuring the NMR response of the sample to identify the NMR response of protons in the sample that are associated with fats and oils; and

comparing the NMR response of the sample with the known NMR response of similar samples of known fat and oil content to determine the fat and oil content in the sample.

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- 2. A method according to Claim 1 wherein the step of identifying the NMR response comprises measuring the relaxation times of protons in the sample in response to pulsed radio frequencies from the NMR analyzer.

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- 3. A method according to Claim 1 wherein the step of identifying the NMR response comprises measuring the chemical shift spectrum of the sample.

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- 4. A method according to Claim 1 further comprising:
  - weighing the sample prior to the step of drying the sample;
  - reweighing the sample after the step of drying the sample;
  - calculating the percentage of moisture based on the weight change during drying; and
  - calculating the fat and oil content based upon the weight of the sample prior to drying and the fat and oil content determined by analysis of the NMR spectrum.

5. A method according to Claim 1 wherein the step of drying the sample comprises placing the sample on a sample pad that is substantially transparent to microwave radiation and is free of atoms that would interfere with or mask the NMR response of the protons in the fats and oils in the sample.

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6. A method according to Claim 5 wherein the pad is of low mass, porous, hydrophilic and lipophilic.

7. A method according to Claim 5 wherein the pad is formed from materials selected  
10 from the group consisting of glass fibers and quartz fibers.

8. A method according to Claim 1 comprising keeping the sample at a substantially constant temperature during the step of drying the sample.

15 9. A method according to Claim 8 comprising drying the sample at a temperature sufficient to melt at least a portion of the fat and oil in the sample.

20 10. A method according to Claim 5 wherein the step of transferring the sample to the NMR analyzer comprises transferring the complete sample and the sample pad to the NMR analyzer.

25 11. A method according to Claim 10 wherein the step of transferring the sample and the sample pad further comprises wrapping the sample and sample pad in a sheet material that is free of atoms that would interfere with or mask the NMR response of the protons in the fats and oils in the sample.

12. A method according to Claim 11 wherein the sheet material is polytetrafluoroethylene.

13. A method according to Claim 1 wherein the step of conducting the NMR analysis is performed at substantially the same temperature as the drying step.

14. A method according to Claim 1 further comprising the step of generating a 5 plurality of NMR spectra of samples of known fat and oil content.

15. A method according to Claim 1 wherein the method is conducted for a plurality of samples immediately after one another.

10 16. A method according to Claim 15 wherein the analysis of the plurality of samples is conducted at a substantially constant temperature from sample to sample.

15 17. A method of rapidly and accurately determining the fat and oil content of a sample that also contains moisture in amounts that would otherwise preclude NMR determination of the fat and oil content, the method comprising:

placing the sample on a sample pad that is substantially transparent to microwave radiation and that is free of atoms that would interfere with or mask the NMR response of the protons in the fats and oils in the sample;

weighing the sample and the sample pad;

20 thereafter drying the sample by subjecting the sample and sample pad to electromagnetic radiation in the microwave frequencies;

transferring the entire sample and sample pad to an NMR analyzer;

measuring the NMR response of the sample to identify the NMR response of protons associated with fats and oils;

25 comparing the NMR response of the sample with the known NMR responses of similar samples of known fat and oil content to determine the fat and oil content in the sample; and

quantitatively determining the fat and oil content in the sample prior to drying.

8. A method according to Claim 17 comprising reweighing the sample and sample pad after drying the sample.

19. A method according to Claim 17 wherein the step of identifying the NMR response comprises measuring the relaxation times of protons in the sample in response to pulsed radio frequencies from the NMR analyzer.

20. A method according to Claim 17 wherein the step of identifying the NMR response comprises measuring the chemical shift spectrum of the sample.

10 21. A method according to Claim 17 and further comprising calculating the percentage of moisture in the sample based on the weight change during drying.

15 22. A method according to Claim 17 comprising keeping the sample at a substantially constant temperature during the step of drying the sample.

23. A method according to Claim 22 comprising drying the sample at a temperature sufficient to melt at least a portion of the fat and oil in the sample.

20 24. A method according to Claim 17 wherein the step of transferring the sample and the pad further comprises wrapping the sample and pad in a sheet material that is free of atoms that would interfere with or mask the NMR response of the protons in the fats and oils in the sample.

25 25. A method according to Claim 17 wherein the step of conducting the NMR analysis is performed at substantially the same temperature as the drying step.

26. A method according to Claim 25 comprising measuring the NMR response immediately following the drying step.

27. A method according to Claim 17 further comprising the step of generating a plurality of NMR response of samples of known fat and oil content.

28. A method of rapidly and accurately determining the fat and oil content of a plurality of samples that also contain moisture in amounts that would otherwise preclude NMR determination of the fat and oil content, the method comprising:

weighing a first sample;

drying the first sample by subjecting the sample to electromagnetic radiation in the microwave frequencies;

transferring the entire first sample to an NMR analyzer;

measuring the NMR response of the first sample to identify the NMR response of protons in the sample that are associated with fats and oils;

comparing the NMR response of the first sample with the known NMR responses of similar samples of known fat and oil content to determine the fat and oil content in the sample; and

repeating the above steps for a second sample.

29. A method according to Claim 28 wherein the step of identifying the NMR response comprises measuring the relaxation times of protons in the sample in response to pulsed radio frequencies from the NMR analyzer.

30. A method according to Claim 28 wherein the step of identifying the NMR response comprises measuring the chemical shift spectrum of the sample.

31. The method according to Claim 28 wherein the second sample is weighed immediately after the first sample.

32. The method according to Claim 28 wherein the second sample is dried immediately after the first sample.

33. The method according to Claim 28 wherein the NMR response of the second sample is measured immediately after the NMR response of the first sample is measured.

34. The method according to Claim 28 wherein the steps of drying the sample and measuring the NMR response occur at substantially the same temperature for the plurality of samples analyzed.

35. A method according to Claim 28 further comprising:  
weighing the first sample prior to the step of drying the first sample;  
10 reweighing the first sample after the step of drying the first sample;  
calculating the percentage of moisture in the first sample based on the weight change  
during drying;  
calculating the fat and oil content of the first sample based upon the weight of the  
sample prior to drying and the fat and oil content determined by analysis of the NMR  
15 spectrum; and  
repeating each of the above steps for the second sample.

36. A method according to Claim 28 wherein the step of drying the sample comprises placing the sample on a sample pad that is free of atoms that would interfere with or mask the  
20 NMR response of the protons in the fats and oils in the sample.

37. A method according to Claim 36 wherein the pad is of low mass, porous,  
hydrophilic and lipophilic.

25 38. A method according to Claim 36 wherein the pad is formed from materials selected from the group consisting of glass fibers and quartz fibers.

39. A method according to Claim 34 wherein the drying step is conducted at a  
temperature sufficient to melt at least a portion of the fat and oil in the sample.

40. A method according to Claim 28 wherein the steps of transferring samples to the NMR analyzer comprises transferring the complete sample and the sample pad to the NMR analyzer.

5       41. A method according to Claim 40 wherein the steps of transferring the sample and the sample pad further comprises wrapping the sample and pad in a sheet material that is free of atoms that would interfere with or mask the NMR response of the protons in the fats and oils in the sample.

10       42. A method according to Claim 41 wherein the sheet material is polytetrafluoroethylene.

15       43. An apparatus for rapidly and accurately determining the fat and oil content of a sample that also contains moisture in amounts that would otherwise preclude NMR determination of the fat and oil content, the apparatus comprising:

      a sample pad for receiving a sample containing fat and oil;  
      a source of microwave radiation for drying the sample;  
      a cavity in wave communication with said source of microwave radiation for receiving the sample and sample pad;

20       a balance with at least its pan in said cavity for weighing the sample and sample pad;  
and

      an NMR analyzer for determining the NMR spectra of the sample and sample pad.

25       44. An apparatus according to Claim 43 wherein said NMR analyzer is a pulsed NMR analyzer.

45. An apparatus according to Claim 43 wherein said NMR analyzer and balance are situated close enough to one another to prevent a significant temperature drop in the sample between drying and determining the NMR spectra of the sample.

46. An apparatus according to Claim 43 wherein said sample pad is substantially transparent to microwave radiation and is free of atoms that would interfere with or mask the NMR response of the protons in the fats and oils in the sample.

5        47. An apparatus according to Claim 46 wherein said sample pad is of low mass, porous, hydrophilic and lipophilic.

10      48. An apparatus according to Claim 46 wherein said sample pad is formed of materials selected from the group consisting of glass fibers and quartz fibers.

15      49. An apparatus according to Claim 43 further comprising a resonant inverter for adjustably supplying power to said source of microwave radiation.

20      50. An apparatus according to Claim 43 further comprising a sheet material that is free of atoms that would interfere with or mask the NMR response of the protons in the fats and oils in the sample, said sheet material being wrapped around said sample and said sample pad during NMR analysis.

25      51. An apparatus according to Claim 50 wherein said sheet material is polytetrafluoroethylene.

25      52. An apparatus according to Claim 43 further comprising a processor for quantitatively assessing the fat and oil and moisture components of the sample prior to drying of the sample.

30      53. An apparatus for rapidly and accurately determining the fat and oil content of a sample that also contains moisture in amounts that would otherwise preclude NMR determination of the fat and oil content, the apparatus comprising:

          a sample pad for receiving a sample containing fat and oil that is substantially

transparent to microwave radiation and is free of atoms that would provide a chemical shift

that would interfere with or mask the chemical shift of the protons in the fats and oils in the sample;

a source of microwave radiation for drying said sample, said source being driven by a resonant inverter for adjustably supplying power to said source of microwave radiation;

5 a cavity in wave communication with said source of microwave radiation for receiving said sample and sample pad;

a balance with at least its pan situated within said cavity for weighing said sample and sample pad;

a NMR analyzer for determining the NMR spectra of said sample and sample pad;

10 and

a processor for quantitatively assessing the fat and oil and moisture components of the sample prior to drying of the sample.

54. An apparatus according to Claim 53 wherein said processor has input and output communication with said microwave source, said balance and said NMR analyzer.

55. An apparatus according to Claim 53 wherein said NMR analyzer is a pulsed NMR analyzer.

20 56. An apparatus according to Claim 53 wherein said sample pad is formed of materials selected from the group consisting of glass fibers and quartz fibers.

57. An apparatus according to Claim 53 further comprising a sheet material that is free of atoms that would interfere with or mask the NMR response of the protons in the fats 25 and oils in the sample, said sheet material being wrapped around said sample and said sample pad during NMR analysis.

58. An apparatus according to Claim 57 wherein said sheet material is a fluorocarbon polymer.

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59. A sample for NMR measurement comprising:  
an organic portion containing at least some fats and oils;  
a pad that is substantially transparent to microwave radiation and is free of atoms that  
would interfere with or mask the NMR response of the protons in the fats and oils in the  
sample;

a sheet material that is free of atoms that would interfere with or mask the NMR response of the protons in the fats and oils in the sample, said sheet material being wrapped around said organic portion and pad.

10 60. A sample according to Claim 59 at a temperature at which the fats and oils are  
partially melted.

61. A sample according to Claim 59 wherein said organic portion is on said pad, and said pad and said organic portion are wrapped in said sheet material.

15 62. A sample according to Claim 59 wherein said pad is hydrophilic and lipophilic.

63. A wrapper for an NMR sample comprising:  
a sheet material that is free of atoms that would interfere with or mask the NMR  
response of the protons in fats and oils in a sample wrapped in said sheet material;  
said sheet having an area large enough to completely wrap a food sample, while small  
enough to fit within the sample field portion of a NMR analyzer when said sheet is wrapped  
around the sample.

25           64. A wrapper according to Claim 63 wherein said sheet material has an area sufficient to wrap both a sample and a sample pad while still small enough to fit within the sample field portion of an NMR analyzer.

65. A wrapper according to Claim 63 that is substantially nonporous to oils, melted fats, and other liquids, and strong enough to withstand being wrapped and folded into a size that fits within the sample field of an NMR analyzer.

5           66. A wrapper according to Claim 63 comprising a fluorocarbon polymer.

67. A wrapper according to Claim 66 comprising polytetrafluoroethylene.